

## **Gross anatomy and radiology Practical – Week 11**

### **Nerves of the upper limb**

#### **Learning objectives:**

Identify the nerves of the upper limb, including the brachial plexus and its parts, on models

Identify the neurovascular bundles of the upper limb on MRI

For each nerve, list the muscles it supplies, and describe or diagram the areas of skin it supplies

Describe or diagram the dermatomes of the upper limb

Predict functional consequences of nerve injuries

#### **Specimens for stations:**

1 – Posterior body wall with nervous system models UA ANS, ANS/1, ANS/2; upper limb model UA349; cervical vertebra model UA235; thoracic cage with brachial plexus and arteries model UA 399; articulated model skeleton

2 – Upper limb models 349/1, 349/2

3 – Upper limb model UA349/3; Hand models UA238, 238/1

4 – Hand model UA238/2; Netter 454, 455

Note: A selection of diagrams and radiological images (e.g., radiographs, computed tomography (CT), and magnetic resonance imaging (MRI)) will be available at most stations.

As you work through the stations, identify the nerves on the models and diagrams provided, and their locations (with accompanying blood vessels, usually) in the MRIs. You may start at any station and proceed in order, e.g. 3→4→1→2.

Answers are provided to the nerve injury questions at the end of the practical worksheet; please attempt the questions prior to looking at the answers.

### **Station 1: Brachial plexus**

You studied the structure of the brachial plexus at the week 7 practical. As revision, sketch the brachial plexus from memory, and then check your drawing against the models and diagram.

Which spinal nerves contribute to each major branch of the brachial plexus? This cannot be completely accurately determined from the diagram, due to some bundles of axons not completing intermingling prior to branching.

Describe the consequences of the following lesions to the proximal parts of the brachial plexus: (hint: think about dermatomes and myotomes)

C7 root or middle trunk of brachial plexus

T1 root (ventral ramus) of brachial plexus

**Station 2: Nerves to muscles of the superficial back, nerves to proximal muscles of the upper limb, and the musculocutaneous and radial nerves.**

Which nerves supply the following muscles that have proximal attachments to the axial skeleton, and move the shoulder girdle and/or humerus?

Trapezius

Latissimus dorsi

Rhomboid major and minor

Levator scapulae

Serratus anterior

Pectoralis major

Pectoralis minor

Subclavius

Which nerves supply the following muscles that connect the humerus to the scapula, and move the arm at the glenohumeral joint? Note there are some muscles in the arm that attach to the scapula and radius or ulna – these will be considered later in this station.

Supraspinatus

Infraspinatus

Teres minor

Subscapularis

Teres major

Deltoid

Coracobrachialis

Which of the above nerves is particularly at risk of damage in a fracture of the surgical neck of the humerus? What would be the consequences of damage to this nerve here?

Which nerve supplies the anterior compartment of the arm? How does this nerve enter the compartment, and between which muscles is it located in the distal arm? What would be the effect of a proximal lesion of this nerve, near its origin from the lateral cord?

Which nerve supplies the posterior compartment of the arm? How does it enter the compartment? It runs in a groove on the posterior surface of the shaft of the humerus, where it is at risk of damage in a fracture. What is the name of this groove? Where is the nerve located at the level of the elbow joint?

Which nerve, and which of its branches, supplies the posterior compartment of the forearm? How does this nerve enter the compartment, and where is it located in the compartment? It is at risk of damage in a fracture of the proximal radius.

Describe the consequences of a lesion of the radial nerve at the proximal radius.

### **Station 3: Median and ulnar nerves**

Identify the median nerve and describe its key anatomical relationships in the arm and forearm, and at the elbow and wrist.

Which compartment in the upper limb does the median nerve supply (except for 1½ muscles), what is the name of its deep branch in this compartment, and which muscles does the median nerve supply in the hand?

Identify the ulnar nerve and describe its key anatomical relationships in the arm and forearm, and at the elbow and wrist.

Which muscles does the ulnar nerve supply in the forearm? Through its deep branch, it supplies all intrinsic muscles of the hand except those supplied by the median nerve, which you noted above.

Describe the motor and sensory loss from a lesion of the median nerve at the elbow.

Describe the motor and sensory loss from a lesion of the ulnar nerve at the wrist.

#### **Station 4: Cutaneous nerves and dermatomes**

Explain the difference between a dermatome and a cutaneous nerve.

Describe or draw diagrams illustrating the dermatome distribution of the upper limb, focusing on the version used in clinical skills workshops, but noting the similarities and differences amongst this and other dermatome maps.

List the cutaneous nerves of the arm, and the nerve and/or cord from which each arises.

List the cutaneous nerves of the forearm, and the nerve and cord from which each arises directly or indirectly.

Which cutaneous nerves supply which areas of skin of the hand? Anteriorly, the nerves branch into common and proper palmar digital nerves. Posteriorly, the nerves branch into dorsal digital nerves.

## Answers to peripheral nerve injury and nerve root injury questions

In answering peripheral nerve injury questions, you need to think about which muscles are supplied by the damaged nerve distal to the site of injury, the functions of these muscles, and whether or not there are other muscles, supplied by other nerves (or proximal to the site of injury of the same nerve), also responsible for those actions. You also need to consider the areas of skin supplied by cutaneous nerve branch/es of the damaged nerve distal to the site of lesion.

In answering nerve root lesion questions, you need to remember the myotome charts (spinal cord segments that are mainly responsible for movements at the various joints). As all movements are controlled by at least 2 spinal cord segments / spinal nerves, damage to one spinal nerve will result in weak, but not lost, movement/s. You also need to recall the dermatome charts (especially the ones used in clinical skills workshops), which illustrate areas of skin supplied by spinal cord segments / nerves.

### C7 root or middle trunk of brachial plexus

- Weak elbow extension (C7-8)
- Weak pronation (C6-7)
- Weak wrist movements (flex C6-7, extend C7-8, ab/adduction)
- Weak finger flexion and extension (C7-8)
- Slightly weak shoulder movements, including adduction (C6-C8), flexion, extension, medial rotation (C5-C8)
- Sensory loss over digit 3 and middle of hand (anteriorly and posteriorly), narrow strip of anterior forearm and arm, posterior forearm

### T1 root (ventral ramus) of brachial plexus

- Weak abduction / adduction of fingers (C8-T1)
- Sensory loss medial arm and forearm (but not near wrist or axilla)

### Axillary n

- Shoulder abduction limited to about 60 degrees due to loss of deltoid. (supraspinatus initiates abduction, scapular rotation by serratus anterior and trapezius are okay)
- Other shoulder movements somewhat weak, except adduction unaffected
- Loss of sensation over deltoid

### Musculocutaneous n

- Elbow flexion very weak due to loss of biceps brachii and brachialis, although there is some flexion by brachioradialis
- Weak supination as biceps brachii is the prime mover, but the supinator is okay
- Sensory loss lateral forearm

The next three are more challenging. They require a solid understanding of the innervation of the muscles of the forearm and hand, and their innervation.

### Radial nerve at the proximal radius

Summary: Loss of extension of digits 2-5 at MCP, thumb extension. Weak supination, wrist extension, wrist abduction & adduction, extension of digits 2-5 at PIP and DIP, thumb abduction. The details of why...

- Weak supination due to loss of supinator; but biceps brachii is fine
- Weak extension of wrist due to loss of extensor carpi radialis brevis (ECRB) and extensor carpi ulnaris (ECU), and other posterior compartment muscles; but extensor carpi radialis longus (ECRL) is supplied by radial nerve proximal to the lesion
- Weak wrist abduction due to loss of ECRB and weak wrist adduction due to loss of ECU
- Loss of extension of digits 2-5 at MCP due to extensor digitorum (ED), extensor digiti minimi (EDM), and extensor indicis (EI)
- Weak extension at PIP and DIP of digits 2-5; but lumbricals and palmar and dorsal interossei are fine
- Loss of thumb extension at all joints due to loss of extensor pollicis longus, extensor pollicis brevis
- Weak thumb abduction due to loss of abductor pollicis longus; but abductor pollicis brevis is fine
- Probably no sensory loss as all cutaneous branches exit radial nerve proximal to radius

(What additional actions would be lost if the radial nerve were damaged more proximally?)

### Median nerve at the elbow

Summary of motor consequences: Loss of pronation of forearm, flexion and opposition of the thumb. Loss or weak flexion of digits 2-5. Weak wrist flexion and abduction. See sensory loss below. The details of why:

- Weak wrist flexion due to loss of flexor carpi radialis (FCR) and palmaris longus; but flexor carpi ulnaris (ulnar n) fine
- Weak wrist abduction due to loss of FCR; but extensor carpi radialis longus and brevis okay
- Loss of pronation at radioulnar joints due to loss of pronator teres, pronator quadratus
- Weak flexion at MCP of digits 2-5 due to loss of FDS digits 2-5 & FDP digits 2,3; but all interossei, and lumbricals and FDP to digits 4&5, fine
- Loss of flexion at PIP & DIP 2&3 due to loss of FDS & FDP, and weak flexion at PIP 4&5 due to loss of FDS; but FDP to digits 4&5 fine
- Loss of flexion and opposition of thumb due to loss of flexor pollicis longus, flexor pollicis brevis and opponens pollicis
- Difficulty of fine control of hand because of motor loss/weakness and sensation (touch and proprioception)
- Sensory loss over anterior surface of lateral hand and first 3 and ½ digits

(What are the effects of median nerve injury in the carpal tunnel?)



Ulnar nerve at the wrist (for example, in ulnar tunnel = Guyon's canal)

Summary: Loss of abduction and adduction of digits 2-5, adduction of thumb.

Slight weakness of flexion at MCP and extension at PIP and DIP of digits 2-5 and problems with precision grip. See sensory loss below. In more detail:

- Most intrinsic hand muscles paralyzed: hypothenar eminence muscles (flexor, abductor, and opponens digiti minimi), lumbricals digits 4&5, all palmar and dorsal interossei, adductor pollicis; so:
- Loss of abduction and adduction of digits 2-5 (this occurs at MCP) due to loss of all interossei and abductor digiti minimi
- Loss of adduction of thumb due to loss of adductor pollicis
- Slightly weak flexion at MCP and extension at PIP and DIP of digits 2-5 due to loss of lumbricals 4&5, all palmar and dorsal interossei, and flexor digiti minimi; but...
  - flexor digitorum superficialis and profundus and lumbricals 2&3 fine
  - extensor digitorum, extensor indicis, extensor digiti minimi and lumbricals 2&3 fine
- This will result in problems with fine control of digits 2-5 especially precision grip which requires coordinated flexion at MCP and extension at PIP and DIP by interossei and lumbricals
- Sensory loss over the anterior surface of fifth and medial half 4<sup>th</sup> digit (note dorsal and palmar branches exit the nerve proximal to the lesion so medial palm and dorsum of hand likely fine)

(What are the effects of ulnar nerve injury near the elbow?)

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